

Water from Water

The **DESALINATION & WATER PURIFICATION R&D PROGRAM** Newsletter – No. 28

PROGRAM OVERVIEW

Bureau of Reclamation Commissioner John Keys announced November 28, 2005, that Reclamation has provided over \$1.7 million for 16 desalination research cooperative agreements from FY 2005 funding. Including the matching contributions, the total investment in desalination research is over \$6 million.

The cooperative research agreements were awarded to water utilities, universities, and private companies across the country and represent a broad range of needed research in desalination and water reuse. There are eleven research and laboratory studies, one new pilot test, and one demonstration project funded. Three previously funded pilot tests were renewed for completion of the test.

PROJECTS AWARDED

The objective of the DWPR program is to increase the rate of development of new technologies for reducing costs of water treatment and to promote the implementation of solutions in order to meet the water supply challenges of the future. These projects address membrane fouling and cleaning, concentrate disposal, membrane bioreactor evaluation, use of renewable energy (in this case wind energy), process improvements, mass transfer enhancement, treatment of produced waters and new process development.

Evaluation and Selection of Available Processes for a Zero-Liquid Discharge System for the Perris, California Groundwater Basin

The principal investigator is Behrooz Mortazavi from Eastern Municipal Water District of Perris, California. Even though the water district is located in close proximity to the Pacific Ocean, it has a serious problem with concentrate disposal. This research will evaluate a number of possible means of concentrate disposal in a real-world setting. Total project cost is \$292,051; Reclamation's contribution \$99,989.

Reduced Membrane Fouling Potential by Tailored Fluid/Structure Interaction

The principal investigator is Kevin Farrell from Heat Transfer Research. This will be a computer simulation of flow around turbulence promoters within spiral wound reverse osmosis elements. The objective is to determine favorable conditions that can use the alternating shear stresses to decrease the fouling potential at the membrane surface. Total project cost is \$40,000; Reclamation's contribution \$10,000.

Use of Dendrimers to Enhance Selective Separation by Nanofiltration and Reverse Osmosis Membranes

The principal investigator is Craig Bartels from Hydranautics. In some desalination applications, a number of minor components, such as boron and nitrate have to be removed to meet water quality requirements. This research will study whether it is efficient to disperse dendrimers, an adsorbent, for particular materials into the water where they will attract specific components which will then be rejected by the membranes rather than developing specific membranes for each minor component. Total project cost is \$144,400; Reclamation's contribution \$72,200.

Evaluation of Newly Developed MBR Systems for Water Reclamation

The principal investigator is James DeCarolis from MWH Americas in Pasadena, California. The use of membrane bioreactors for reclamation of municipal wastewater has increased significantly in the past few years. Under this project, third-party performance evaluations and Title 22 approval testing of newly developed MBR systems will be performed. Additionally, the performance of RO systems following the MBRs will be evaluated and cost estimates for the MBR/RO process will be updated and refined. Total project cost is \$558,184; Reclamation's contribution \$99,960.

Wind Power and Water Desalination Technology Integration

The principal investigators are Ken Rainwater and Andy Swift from Texas Tech University. This project will investigate and quantify system designs and economics of integrated wind-water systems. The work will focus on municipal, ranch and farm, and industrial applications. Work will include representative systems designs, assessment of



economic trends and market forces, estimates of market size and projected system economics. Total project cost is \$99,970; Reclamation's contribution \$99,970.

Electrocoagulation Pretreatment for Microfiltration: An Innovative Combination to Enhance Water Quality and Reduce Fouling

The principal investigator is Shankar Chellam from the University of Houston. Previous research indicated that electrocoagulation, use of electricity to remove contaminants instead of chemicals, is an effective method of pretreatment for integrated membrane systems. This research will show whether the promising results obtained with synthetic waters are valid for natural surface waters, characterized by turbidity, natural organic matter and other contaminants. Total project cost is \$147,781; Reclamation's contribution \$99,881.

Characterization of Membrane Foulants in Seawater Reverse Osmosis Desalination

The principal investigator is Mark Clark from the University of Illinois at Urbana-Champaign. This project will focus on fractionating seawater foulants by size to determine what type of foulants are the major contributors to membrane fouling. A variety of analytical techniques will be used to characterize the foulant materials. Total project cost is \$124,679; Reclamation's contribution \$98,470.

Techno-Economic Feasibility Study of Wind Powered Desalination for a Community Scale Distributed Generation Application

The principal investigator is James Manwell from the University of Massachusetts. The Town of Hull, MA, is considering use of a seawater desalination plant, primarily driven by wind power, to augment their water supply. The results of this project will provide a study of desalination powered by renewable energy based on real-life economics and logistics. Total project \$99,914; Reclamation's contribution \$99,914.

Desalination Pretreatment Using Controlled-Chain PEGMA-Enhanced Cellulose Acetate Ultrafiltration

The principal investigator is Isabel Escobar from the University of Toledo. This project will focus on development of a polyethylene glycol monomethacrylate (PEGMA) enhanced cellulose acetate ultrafiltration membrane. This type of modification, if successful, will reduce fouling of pretreatment membranes and . Traditional use of ultrafiltration as pretreatment for membrane desalination has increased dramatically over the last decade. The advantages are that it produces higher quality feed water in a smaller space. However, ultrafiltration membranes are prone to fouling. Total project cost is \$166,878; Reclamation's contribution \$92,411.

Barriers to Thermal Desalination in the United States

The principal investigator is John Tonner from Water Consultants International. While much of the rest of the world uses thermal process for desalination, only reverse osmosis appears to be considered for large seawater desalination plants in the United States. The investigation will summarize what barriers, regulatory and other, prohibit use of thermal desalination here. Total project cost is \$73,150; Reclamation's contribution \$35,038.

Optimization of Chemical Cleaning of Organic-Fouled Reverse Osmosis Membranes

The principal investigator is Menachem Elimelech from Yale University. Fouling continues to be one of the major impediments in the application of RO membranes in water treatment. This project will assess the applicability of various cleaning chemicals with respect to cleaning efficiency, cleaning cost and environmental impact. It includes development of a methodology to select the optimal combination of chemical cleaning agents based on the foulant concentrations. Total project cost is \$97,570; Reclamation's contribution \$97,570.

Seawater Desalination Pilot Project

The principal investigator is Alvin Bautista from Los Angeles Water and Power. LAWPD plans to build the first seawater desalination plant for the City of Los Angeles. Prior to developing a full scale facility, a 40-gallon-per minute pilot project is planned that will focus on the technical feasibility and cost of using water discharged from an existing power generating station's condenser. Technologies developed by the project will be applicable at other locations in the United States that seek a similar application. Total project cost is \$2,421,000; Reclamation's first year contribution \$150,000.

Dana Point Ocean Desalination Project

The principal investigator is Richard Bell from the Municipal Water District of Orange County. The purpose of this project is to advance the utilization of Horizontal Directional Drilling (HDD)/slant well technology for construction of feed water supply systems for ocean desalination plants sited near the mouths of stream or river systems. This demonstration project addresses the technical, economical and operational feasibility of HDD/slant well technology in alluvial marine aquifers for ocean feed water supply and pretreatment. Total project cost is \$1,458,107; Reclamation's contribution \$360,000.

Pilot-Scale Studies for Direct Contact Membrane Distillation-Based Desalination Process

The principal investigator is Kamallesh Sirkar from New Jersey Institute of Technology. Direct Contact Membrane Distillation (DCMD) is a process in which

warmer supply water flows over a membrane with cooler water on the other side. A special hollow fiber membrane has been developed for this process. The roles of brine velocity, brine feed temperature, distillate flow rate brine concentrate recirculation rates and others are being determined. Cost estimates of water production will be developed to permit comparison of DCMD with established desalination technologies. Total project cost is \$309,811; Reclamation's second year contribution \$119,815.

Pilot Testing of Zero-Discharge Seawater Desalination

The principal investigator is Thomas Davis from the University of South Carolina. The ZDD process is based on the premise that seawater has several valuable constituents, but their value can only be realized if their separation is economically and technically feasible. Under a previous contract, a hybrid reverse-osmosis-electrodialysis-nanofiltration process was developed and verified for a batch process. Total project cost is \$270,000; Reclamation's second year contribution \$100,000.

Membrane Technology for the Recovery of Produced Water

The principal investigator is Alan Bierle from Western Environmental Management. An abundance of produced water is generated when removing oil and gas from the ground. Disposal can be either environmentally damaging or expensive or both. This pilot scale unit contains ultrafiltration, nanofiltration and reverse osmosis units. Verification of technology and operating data for each unit are being measured at an oil field injection well site in Carlsbad, NM. Feasibility capital and maintenance costs will be developed. Total project cost is \$471,925; Reclamation's second year contribution \$84,999.